MORSE

Rattler Test Requirements For Paving Brick & Block

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RATTLER TEST REQUIREMENTS FOR PAVING BRICK AND BLOCK

...BY...

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This is to certify that the following thesis, prepared under the direction of Professor A. N. Talbot, Head of the Department of Municipal and Sanitary Engineering, by HENRY CHARLES MORSE, entitled RATTLER TEST REQUIREMENTS FOR PAVING BRICK AND BLOCK, is accepted by me as fulfilling this part of the requirement for the degree of Bachelor of Science in Civil Engineering.

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Rattler Test Requirements for Paving Brick and Block.

The use of paving brick is comparatively new. They were first used in America about thirty years ago and came into general use less than eighteen years ago. The brick first used for paving were not of a good quality but their adaptability to this use and their increasing popularity as a paving material has lead manufacturers to experiment in their manufacture until now brick are made which are as nearly perfect as is possiable. The different kinds of material used in the manufacture of brick and the different methods of pressing, drying and burning has resulted in brick being put on the maiket which vary greatly in their physical properties. In order to obtain brick which will surely give satisfactory results when put into a pavement, it is necessary to obtain beforehand some idea of the physical properties of the brick. This leads to different tests

being applied to the brick, the most important of which are the ones which show the durability of the brick under conditions similiar to those met with in a pavement, and not merely their strength. There are six tests commonly applied to brick which are enumerated below with a brief statement of their purpose.

I Abrasion:- This test shows the ability of the brick to resist rubbing and grinding, as by the rolling and grinding of heavily loaded wagons over a pavement.

II Impact:- This test shows the ability of the brick to resist a direct blow, as by the impact of horse's shoes and wagon wheels on a pavement.

III Cross breaking:- This test shows the ability of the brick to sustain heavy loads without any injury to the brick.

IV Crushing:- This test shows the ability of the brick to resist direct pressure. It may or may not be an indication of the homogeneity of the material. It is generally assumed that results from this test and the cross-breaking test are parallel and depend upon the physical properties of the

brick.

V Specific Gravity:- This test shows the density of the material but its value as an indication of the wearing ability of the brick is too small to be considered.

VI Absorption:- This test shows the porosity of the brick. The chief merit of this test is that it is an indication of the ability of the brick to resist the action of frost and also shows the degree of burning which the brick has received.

The first two tests enumerated are as near as possible the same action as is brought upon the brick in a pavement. Examination of pavements shows that the wear upon the brick results from a grinding of the tops and a chipping of the edges. We may therefore conclude that tests which show the ability of the brick to resist such action are the most valuable and most engineers have adopted the impact and abrasion test as being best suited for this purpose. These two tests are usually merged into one called the impact and abrasion test, or the rattler test. Until quite recently each engineer specified a different method of making

these tests and this lack of uniformity brought these tests into disrepute with brick manufacturers. For almost every engineer specified different details for conducting the work and as a consequence the brick manufacturer was not able to judge whether or not their brick would meet the requirements. This difficulty was partially eradicated by the National Brick Manufacturers Association. Prof Edward Orton Jr. of Columbus Ohio was appointed to make some tests to determine if possible the best method of making these tests in order to allow the association to specify this method as a standard. He made a preliminary report at the meeting of the association held in Atlanta, Georgia, in December 1895. Tests were also conducted in the Laboratory of Applied Mechanics at the University of Illinois. The tests were first made in a rattler 15 inches in diameter and 24 inches in length, which was filled about one third full of foundry stars weighing from one to three ounces each and one or two brick of the kind which were to be tested were put in. Later miscellaneous scrap iron was substituted for the foundry stars. A rattler

was finally adopted by the National Brick Manufacturers Association, after a careful study of all the tests previously made and all available information upon the subject. which was to be in the shape of a cylinder 28 inches in diameter and 20 inches long. The charge of shot consists of 75 pounds of cast iron cubes 2½" x 2½" x 5¼" weighing approximately 7½ pounds and 225 pounds of cast iron cubes 1" x 1" x 1". The rattler shall be run at the rate of 30 revolutions per minute for 1800 revolutions. The action taken by the National Brick Manufacturers Association was a solution of this difficulty as it made a standard by means of which all brick are tested. But this test was still unsatisfactory as it gave no idea in regards the uniformity of the individual brick, merely determining the average loss of two charges of brick. Mr. C. Jones, City Engineer of Geneva N. Y. made an improvement upon the rattler used by the National Brick Manufacturers Association. His rattler was designed to carry the brick in pockets on the inside of the staves of the rattler a charge of cast iron shot then being put in. In 1900

Prof. A. N. Talbot proposed a substitute for the rattler designed by Mr Jones. in which the brick are clamped against the inside of an iron cylinder by means of bolts between the bricks and bearing upon their ends. In this manner the brick form a lining to the cylinder which more closely represents the brick as they appear in a pavement than would be possible by means of any other method.

It is the purpose of this work to find the losses which may be allowed in bricks and blocks which are to be used in pavements.

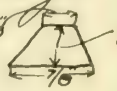
Description of Apparatus.

The Talbot-Jones rattler is made of a short cylinder of sheet steel, the brick being clamped against the inside of this cylinder. The sheet steel cylinder is fastened to a cast iron face plate by means of bent steel bars. A space of 5/16 inches is left between the face plate and the cylinder to allow the chips and dust to escape. A T shaped groove is made around the face plate about 1/4 inches from

the outside circumference - This groove opens to the front and the heads of the bolts are placed there in by means of several holes drilled through the face plate into the T shaped groove. About 3½ inches from the circumference the face plate is recessed ⅞ inches. This arrangement leaves the inner edge of the brick unsupported, allowing the cast iron cubes to have their action upon the full length of the brick. Wooden shims or spacers are placed between the brick to keep them properly spaced during the entire test. A steel screen cover, recessed like the face plate, is used to cover the open end of the rattler. In making these tests two sizes of shot were used 1 inch cast iron cubes and 2½ inch cast iron cubes. The spacing was kept constant, ½ inch, throughout the tests.

Charge and Speed

In the Talbot-Jones rattler enough brick or block were used to completely fill the circumference. This number is about 25 or 26 blocks of the ordinary size, or about 33 ordinary paving brick. This number depends

somewhat upon the spacing used. The spacing used in these tests was as nearly uniform as possiable wooden shims being placed against the inner circumference of the rattler between the brick. the distance between bricks at the inner face being about 1/2 inch, the size of the shims or spacers being as follows. 

The charge of cast iron shot consisted of 30 pounds of 2 1/2 inch cast iron cubes, 45 pounds of 1 1/2 inch cast iron cubes, the individual cubes being replaced by new ones as soon as they had lost ten percent of their original weight. The speed was about thirty six revolutions per minute the rattler being run for six thousand, 6,000, revolutions at this speed. At the end of three thousand revolutions the rattler was stopped in order to tighten any of the bolts which may have worked loose during the process of the test. The chips were weighed at the end of 3000, 4,500 and 6000 revolutions as a check upon the final result.

The charge used in the standard rattler consisted of nine blocks or twelve bricks together with 300 pounds of cast iron shot. The charge of shot consisted of

225 pounds of 1½ inch cast iron cubes and 75 pounds of rectangular cast iron blocks 2½ inches square by 4½ inches long, weighing about 7½ pounds each. The individual shot were replaced by new ones as soon as they had lost ten percent of their original weight. The speed used in these tests was about 30 revolutions per minute the rattler being run for 1800 revolutions at this speed. The time required for making the tests was noted as a check on the counter.

Brick and Block Tested.

The brick used in these tests were: three degrees of burning from The Western Paving Brick Co at Danville Ills, namely Overburned, No 1 Red, and No 1 Brown; two degrees of burning from Terra Haute, No 1 standard and No 2 soft; Purington at Galesburg Ills, standard. These brick were carefully selected at the diffrant yards and ran very evenly in respect to weight, size and color.

The block used in these tests were:- four degrees of burning from The Western Paving Brick

Co at Danville Ills. Overburned. Underburned. No 1 Red and No 1 Brown; two grades from Terra Haute. No 1 Standard and No 2 Soft; Perrington at Galesburg Ills. Standard; Culver, Standard; and some Springfield Granite. which had been in actual use in Pavements at Springfield Ills. These block were also carefully selected at the different yards and ran very evenly in respect to weight, color, and size.

Condition of Tests.

The number of revolutions of each rattler during each test was recorded by a counter and this number was in turn checked by tasting the time of the tests. All brick had been standing for at least 60 days in a warm steam heated room before they were tested and were thoroughly dry. The sharp edges of the cast iron shot were worn off before they were placed in the rattler and used in making a test. The Western Pavers and Terra Haute Brick and Block were graded by the manufacturers before they were shipped and again graded by the writter before they

were tested. The Purington Brick and Block were good specimens of the best product from that plant. The Springfield Block were taken from the pavements at Springfield Ills where they had been under direct and moderately heavy trafic in a city of 40,000 inhabitants. The Cleveland Brick and Block were graded by the manufacturers before being shipped and were again graded by the writter before they were tested. The Culver Block were good specimens of the best product from that plant. All brick were carefully weighed to the hundredth part of a kilogram upon a pair of very delicate scales.

Results of Tests

Table I gives a summary of the tests made in this work upon the diffrant brick and block tested with the Talbot-Jones rattler and the Standard rattler. The losses were computed in percent of the original weight. Table II gives the results of the tests made with the Standard rattler. On account of the variation found in the tests made with the Standard rattler, duplicate tests should

always be made. The original weight, the final weight, the percent lost, including the mean of the two tests are shown.

Tables III. IV and V show the results in detail and give the losses of the individual brick in the Talbot-Jones rattler. By these tables the manner in which the individual brick or block vary from the mean may be readily seen. In the Thesis of John Fred Deutschmann may be found similar tables showing the results of the tests with the Talbot-Jones rattler not shown here.

On Plate I the results of the tests with both rattlers are platted. These diagrams show the manner in which the different makes of brick vary with one another. The vertical scale shows the percent of loss, the brick being platted in the order of their loss in the Standard rattler. The reference numbers refer to Table I.

Plate II shows the results in the same manner for paving block.

Conclusion.

In conclusion, it is the opinion of the

writer that the Rattler or Impact and Abrasion test should be adopted for the testing of paving block and brick. It is self evident that this test gives results which are more nearly like the conditions found in the pavement than any other test which could be applied to the brick. In wasting these tests one should be careful not to draw any conclusion, as to the value of any brick tested, for paving purposes, without taking into careful consideration all the factors upon which may depend the losses from that particular grade of brick. Referring to Plate II it may be seen that some values may appear erroneous unless the nature of of the brick is considered. Take for example the Terre Haute Standard (Reference Number 11). Their test in the Talbot Jones rattler is good, showing a smaller loss than is required for heavy traffic, while in the test of the same brick by the standard rattler they rank just a little better than a soft brick. This apparent contradiction of results is caused by the fact that the Terra Haute brick are void of any glazing. It has been shown that the tests made in the Talbot

Jones rattler and the standard rattler vary greatly upon glazed and unglazed brick, and this contradiction is caused by that fact.

The test requirements for block for paving purposes with the Talbot-Jones rattler should not exceed 10-7½ and 5 percent of their original weight for pavements under light, medium and heavy traffic respectively. Blocks which lose more than 10 percent of their original weight with this rattler should not be placed in pavements as they are either too soft and will soon wear out or they are too hard and will soon be broken in pieces by the impact of the horses shoes. Block for pavement subject to heavy loads should not lose more than 5 percent of their original weight. Blocks taken from pavement where they have been subject to heavy traffic and have stood the wear lose less than 5 percent and 5 percent has been chosen as the maximum allowable percent of loss for heavy traffic.

The requirements for block in the standard rattler should not exceed 24-21 and 17 percent loss of their original weight for pavements under light, medium and heavy

traffic- The reason for this choice of allowable losses is the same as the requirements for the Talbot- Jones rattler-

In the same way the test requirements for brick should not exceed 28- 25 and 21 percent of their original weight in the Standard rattler for pavements for light, medium and heavy traffic respectively, nor more than 14- 11 and 9 percent of their original weight in the Talbot- Jones rattler for pavements under light, medium and heavy traffic respectively.

The amount of these test requirements and their relations to the losses of the block and brick tested are shown on Plate I and Plate II-

TABLE I.

SUMMARY OF RESULTS.

BRICK.

REF. No.	MAKE	GRADE	SIZE.	LOSS IN PER CENT	
				TALBOT - JONES	STANDARD.
1.	WESTERN PAVERS	OVERBURNED	2½" x 4¼" x 9"	18.8	35.6 *
2.		No. 1 RED	2⅜" x 4" x 8¾"	9.7	24.3 *
3.		No. 1 BROWN	2 1/16" x 4 1/16" x 8 7/16"	10.2	22.3 *
4.	TERRE HAUTE	No. 1 STANDARD	2½" x 3⅞" x 8½"	9.8	28.4 *
5.		No. 2 SOFT	2½" x 3 15/16" x 8⅛"	15.2	31.2 *
6.	PURINGTON	STANDARD.	2 1/16" x 4" x 8¼"	4.0	15.6 *

BLOCK.

REF. No.	MAKE	GRADE	SIZE	LOSS IN PER CENT	
				TALBOT - JONES	STANDARD
7.	WESTERN PAVERS	UNDERBURNED.	3¼" x 4¼" x 8⅜"	13.3	30.2 *
8.		OVERBURNED	3⅜" x 4⅛" x 8 5/16"	12.0 *	27.4 *
9.		No. 1 RED	3¼" x 4" x 8 5/8"	5.0	16.5 *
10.		No. 1 BROWN	3¼" x 4" x 8½"	7.6 *	17.8 *
11.	TERRE HAUTE	No. 1 STANDARD	3" x 3⅞" x 8⅜"	4.2	20.6 *
12.		No. 2 SOFT	3 3/16" x 4⅛" x 8 15/16"	18.1	31.2 *
13.	PURINGTON	STANDARD	3½" x 4" x 8¼"	2.4	13.3 *
14.	SPRINGFIELD	GRANITE	2⅞" x 4" x 8½"	4.5 *	15.3 *
15.	CULVER	STANDARD	3¼" x 4" x 9"	5.6	15.2 *
16.	CLEVELAND	DURO	3 5/8" x 3 5/8" x 8¼"	5.6	20.0 *
17.		CANTON	3 5/8" x 4" x 8½"	8.4	17.0 *

* = MEAN OF DUPLICATE TESTS.

TABLE II

TESTS WITH STANDARD RATTLER.

REF. NO.	FIRST TEST			SECOND TEST			MEAN
	ORIGINAL WEIGHT	FINAL WEIGHT	LOSS IN PER CENT	ORIGINAL WEIGHT	FINAL WEIGHT	LOSS IN PER CENT	
1.	37.99	24.55	3.52	38.17	24.66	3.54	3.56
2.	38.76	29.25	24.5	38.94	29.55	24.5	24.3
3.	38.76	29.28	22.6	39.00	29.52	22.0	22.3
4.	38.27	27.34	27.9	38.11	26.81	28.9	28.4
5.	37.50	25.79	31.5	38.00	26.28	30.9	31.2
6.	29.86	25.27	15.4	29.98	25.24	15.8	15.6
7	39.06	27.53	29.6	39.82	27.57	30.8	30.2
8.	37.55	27.45	26.9	37.83	27.29	27.9	27.4
9.	38.59	30.14	16.7	38.41	32.15	16.3	16.5
11.	34.83	27.58	20.8	34.72	27.57	20.4	20.6
12.	34.38	23.85	30.6	34.50	23.55	31.8	31.2
13	38.64	33.42	13.5	38.60	33.54	13.1	13.3
14	29.76	25.26	15.1	29.82	25.20	15.5	15.3
15.	38.43	32.67	15.0	38.51	32.54	15.5	15.2
16.	41.46	33.11	20.1	41.42	33.15	19.95	20.0
17.	40.21	33.04	17.8	40.20	33.71	16.1	17.0
10.	38.28	31.76	17.0	38.44	31.29	18.6	17.8

TABLE III

CLEVELAND BRICK CO.

DURO BLOCK.

No	WEIGHT BEFORE	WEIGHT AFTER	AMOUNT LOST	PER CENT LOST
1.	4.201	3.936	0.265	6.26
2.	4.120	3.929	0.191	4.64
3.	4.135	3.810	0.325	7.85
4.	4.095	3.875	0.220	5.38
5.	4.070	3.824	0.246	6.05
6.	4.171	3.701	0.470	11.30
7.	4.128	3.950	0.178	4.21
8.	4.191	3.973	0.218	5.21
9.	4.132	3.976	0.156	3.78
10.	4.171	3.980	0.191	4.58
11.	4.164	3.940	0.224	5.39
12.	4.124	3.960	0.164	3.98
13.	4.155	3.894	0.256	6.15
14.	4.105	3.921	0284	6.92
15.	4.153	3.845	0.308	7.42
16.	4.195	4.000	0.195	4.65
17.	4.126	3.824	0302	7.33
18.	4.090	3.821	0.269	6.58
19.	4.151	3.887	0.264	6.35
20.	4.202	3.858	0.344	8.19
21.	4.207	3.985	0.222	5.28
22.	4.190	3.977	0.213	5.08
23.	4.107	3.919	0.188	4.58
24.	4.098	3.800	0.298	7.27

Average loss = 5.61 %

TABLE IV

SPRINGFIELD BRICK CO.

GRANITE BLOCK

No.	WEIGHT BEFORE	WEIGHT AFTER	AMOUNT LOST	PER CENT LOST
1.	3.36	3.20	0.16	4.76
2.	3.28	3.10	0.18	5.50
3.	3.30	3.18	0.12	3.62
4.	3.26	3.12	0.14	4.30
5.	3.24	3.09	0.15	4.63
6.	3.26	3.06	0.20	6.14
7.	3.25	3.06	0.19	5.85
8.	3.30	3.07	0.23	6.98
9.	3.22	2.77	0.45	14.00
10.	3.41	3.26	0.15	4.40
11.	3.43	3.22	0.21	6.13
12	3.24	3.10	0.14	4.32
13.	3.39	3.23	0.16	4.72
14.	3.44	3.34	0.10	2.90
15	3.35	3.24	0.09	2.68
16.	3.29	3.18	0.11	3.34
17.	3.53	3.45	0.08	3.06
18	3.39	3.31	0.08	3.18
19.	3.33	3.22	0.11	3.30
20	3.42	3.28	0.14	4.10
21.	3.23	3.08	0.15	4.64
22.	3.25	3.07	0.18	5.54
23.	3.32	3.18	0.14	4.22
24	3.45	3.40	0.05	1.45
25.	3.30	3.18	0.12	3.64
26.	3.37	3.19	0.18	5.35
27.	3.25	3.05	0.20	6.15
28.	3.36	3.30	0.06	1.79
29.	3.22	3.11	0.11	3.42
30.	3.32	3.20	0.20	3.62
31.	3.30	3.12	0.12	5.45

TABLE V

CLEVELAND BRICK CO

CANTON BLOCK.

No.	WEIGHT BEFORE	WEIGHT AFTER	AMOUNT LOST	PER CENT LOST
1.	4.472	3.935	.537	12.0
2.	4.487	4.121	.366	8.15
3.	4.375	3.475	.900	20.6
4.	4.451	4.150	.301	6.77
5.	4.474	4.190	.284	6.35
6.	4.450	4.280	.170	3.91
7.	4.486	3.985	.501	11.98
8.	4.500	4.073	.427	9.48
9.	4.487	4.083	.404	9.00
10.	4.423	4.060	.363	8.22
11.	4.473	4.167	.306	6.85
12.	4.356	3.990	.366	8.40
13.	4.423	4.082	.341	7.71
14.	4.450	3.735	.715	16.7
15.	4.451	3.915	.536	12.05
16.	4.502	4.215	.287	6.38
17.	4.417	4.103	.314	7.11
18.	4.517	4.250	.267	5.91
19.	4.470	4.140	.330	6.64
20	4.463	4.105	.358	8.03
21	4.464	3.893	.571	12.8
22	4.470	4.235	.235	5.26
23	4.484	4.274	.207	4.62
24.	4.475	4.162	.315	7.00

TEST REQUIREMENTS FOR BLOCK.

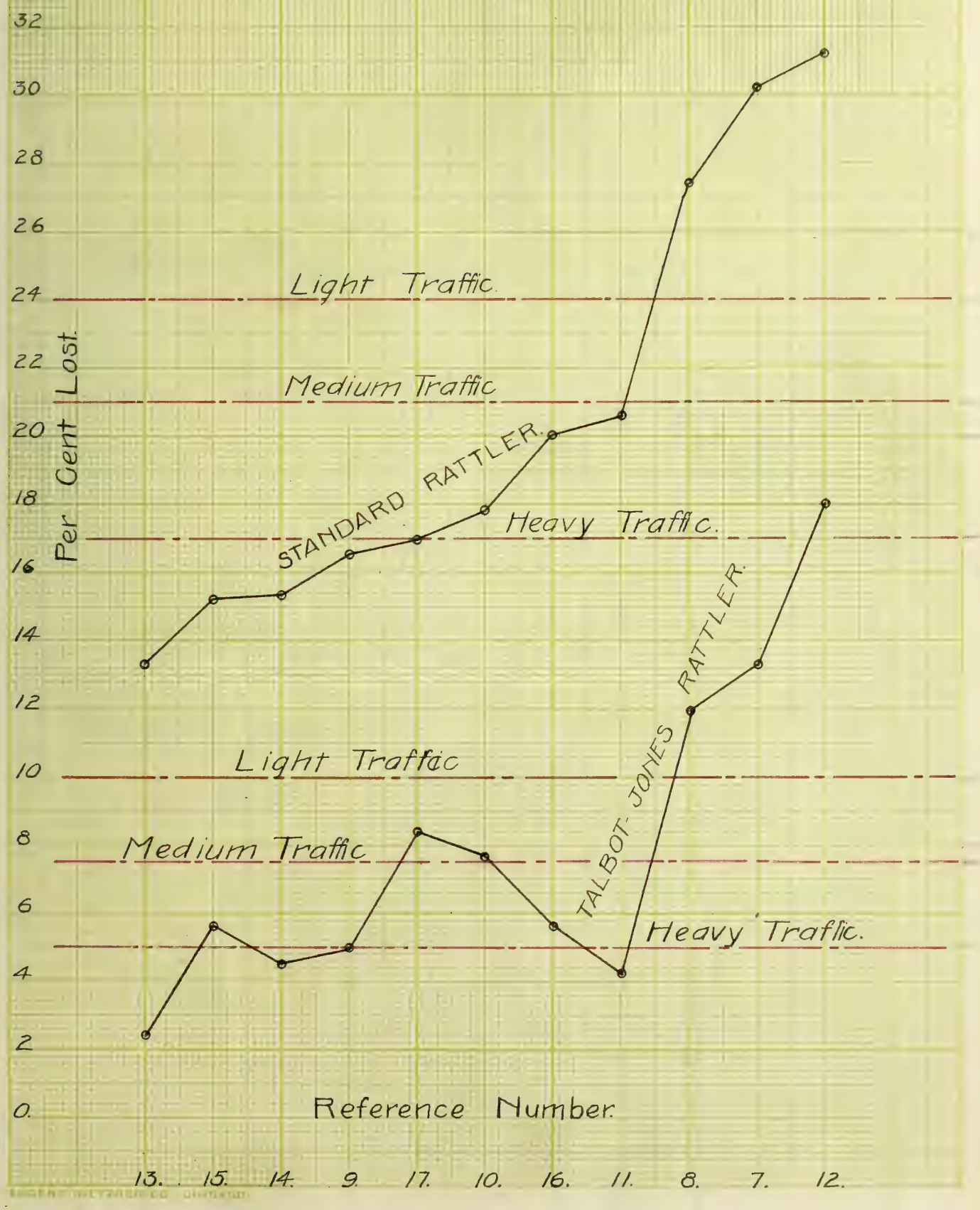
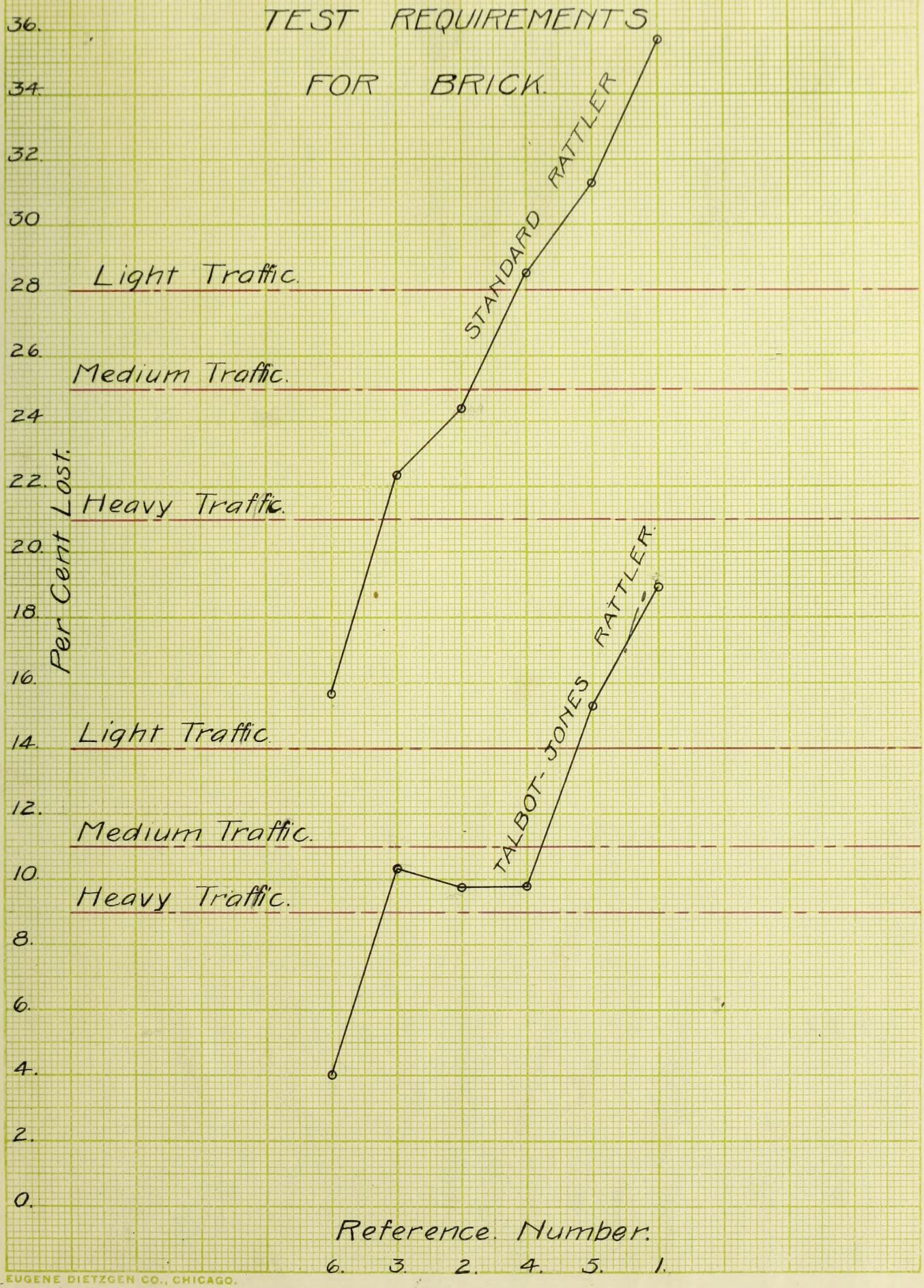


PLATE II

TEST REQUIREMENTS FOR BRICK.



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